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## (54) MANUFACTURING METHOD FOR BIODEGRADABLE FIBER-REINFORCED PLASTICS

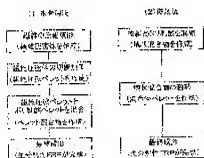
(57)Abstract:

PROBLEM TO BE SOLVED: To provide a manufacturing method for biodegradable fiber-reinforced plastics composed of a combination of cellulose fiber and polylactic acid requiring a kneading process and without deterioration.

SOLUTION: This method is for manufacturing the biodegradable fiber-reinforced plastics composed of the cellulose fiber bonded with the polylactic acid. The method comprises a process of compression-molding the cellulose fiber into a fiber consolidated material; a process of cutting the fibrous consolidated material into fibrous consolidated pellets; a process of mixing the fibrous consolidated pellets with polylactic acid pellets; and a process of molding the obtained pellet mixture at a higher than a melting point of the polylactic acid.

図1

本発明は繊維強化プラスチックの製造方法



[0001]

[Field of the Invention]

This invention relates to the manufacturing method of the biodegradable fiber reinforced plastic (biodegradable FRP) which combined the cellulosic fiber with polylactic acid.

[0002]

[Description of the Prior Art]

In recent years, application of the biodegradable plastic to various fields is considered for the purpose of environmental protection etc., and the biodegradable fiber reinforced plastic which combined the cellulosic fiber (natural fiber) by the biodegradable plastic is also developed as part of that.

[0003]

For example, the biodegradable fiber board which was made intermingled, carried out heat pressing of the biodegradable plastic to the cellulosic fiber (natural fiber), and fabricated it as a binder to it is indicated by the patent documents 1 (JP,2000-127117,A). In this method, a cellulosic fiber and a biodegradable plastic are kneaded above the melting point of a biodegradable plastic, it is considered as a massive mixture, compression molding of the mixture pellet which ground this is carried out at the temperature more than the melting point of a biodegradable plastic, and it is considered as a biodegradable fiber board.

[0004]

Polylactic acid attracts attention as one of the above-mentioned biodegradable plastics. Polylactic acid is a plastic which uses as a raw material the sugar extracted from vegetation, such as maize, a sweet potato, and a cane. Even if it compares especially the polylactic acid of the amount of polymers obtained by the direct polymerization method with polyethylene and polystyrene which are general-purpose plastics, it has sufficient intensity.

As compared with other biodegradable plastics, transparency is also high and is provided with the characteristic which excelled [ bottom / of the damp environment ] in mold not growing etc.

[0005]

this invention person tried to manufacture the biodegradable fiber reinforced plastic which combined polylactic acid with the characteristic outstanding in this way, and a cellulosic fiber by the above-mentioned conventional method. However, the obtained product has low intensity, variation is also large, and also it was not the original white of the raw material, and it had become light brown and there was a problem also in design nature.

[0006]

Since this had the melting point of polylactic acid comparatively as high as about 170 \*\*, it became clear that it was because degradation of polylactic acid and degradation (decomposition and discoloration) of a cellulosic fiber occur during kneading with the cellulosic fiber and polylactic acid which are performed above this melting point.

[0007]

As the measure, when mixing time was shortened, kneading became insufficient, and even if it could prevent discoloration, there was a problem that dispersion in strong occurred.

[0008]

Thus, degradation of intensity and design nature was not able to be avoided in the above-mentioned conventional method of making kneading indispensable.

[0009]

[Patent documents 1]

JP,2000-127117,A (claim)

[0010]

[Problem(s) to be Solved by the Invention]

This invention does not need a kneading process but an object of this invention is to provide the method of manufacturing the biodegradable fiber reinforced plastic (biodegradable FRP) which combined both without degrading a cellulosic fiber and polylactic acid.

[0011]

[Means for Solving the Problem]

In order to attain the above-mentioned purpose, according to this invention, it is a manufacturing method of biodegradable fiber reinforced plastic which combined a cellulosic fiber with polylactic acid,

A process which carries out compression molding of the cellulosic fiber, and is used as a textiles consolidation object,

A process which carries out cut processing of the above-mentioned textiles consolidation object, and is made into a textiles consolidation pellet,

a process of mixing the above-mentioned textiles consolidation pellet and a polylactic acid pellet -- and

A process of fabricating an obtained pellet mixture at temperature more than the melting point of polylactic acid

\*\*\*\*\* -- a method characterized by things is provided.

[0012]

[Embodiment of the Invention]

In the conventional manufacturing method, the processing which kneads a cellulosic fiber and polylactic acid at the temperature more than the melting point of polylactic acid is indispensable, and both degradation occurred in the process. This is because kneading with polylactic acid took the long time since textiles were bulky.

[0013]

That is, although polylactic acid is supplied as a pellet which is a supplying form of the usual plastic and will be in a flow state at kneading temperature, its viscosity is quite high, and it is dramatically difficult to make this and a bulky cellulosic fiber into a uniform mixture state, and kneading takes a long time. As a result, it will be put to the temperature more than the melting point of the polylactic acid of relatively high temperature for a long time, and polylactic acid deteriorates (decomposition depolymerize), the intensity as a binder phase and bond strength fall, not only intensity falls, but a cellulosic fiber carries out decomposition degradation and design nature deteriorates by discoloration (scorch).

[0014]

In the method of this invention, since kneading with a cellulosic fiber and polylactic acid is not performed, the conventional problem of degradation of the intensity and design nature by it is not generated.

[0015]

However, it is necessary to make a cellulosic fiber and polylactic acid into a mixture state. The means has the feature of this invention.

[0016]

That is, in this invention, without using in the bulky state as it is, a cellulosic fiber is used, after carrying out a consolidation with compression molding first. The acquired textiles consolidation object is made into the pellet of size suitable for shaping of a post process by cut processing. The obtained textiles consolidation pellet is mixed with a polylactic acid pellet. If both pellets are made into suitable size, the usual mechanical mixing means can attain the uniform mixed state easily. If the pellet mixture which this prepared is supplied to the hopper of molding equipment and the usual molding operation is performed at the temperature more than the melting point of polylactic acid, biodegradable fiber reinforced plastic of desired shape can be obtained as a composite material of a cellulosic fiber and polylactic acid.

[0017]

Since a kneading action will be obtained in molding equipment if shaping of a pellet mixture is desirably performed by carrying out plastic flow of this pellet mixture compulsorily under application of pressure, uniform mixture-ization of both pellets can be promoted. As a concrete means which carries out plastic flow compulsorily under application of pressure, extrusion and injection molding are suitable.

[0018]

Process drawing of this invention method and process drawing of a conventional method are shown in drawing 1 by comparison.

[0019]

[Example]

By the method of this invention, the biodegradable fiber reinforced plastic which combined the cotton fiber with polylactic acid was manufactured. As shown in drawing 2, it carried out in the following procedures.

[0020]

(1) Pretreatment of textiles

Moisture is given to a cotton fiber. The grade which makes textiles become wet may be sufficient as this. Textiles become flexible by this and press-forming nature becomes good. Although the spray was used like a graphic display in this example, what is necessary is just a method which does not need to limit to in particular this and can give optimum dose of moisture to textiles.

[0021]

(2) Forming by compression of textiles (creation of a textiles consolidation object)

Forming by compression of the cotton fiber made to become wet as mentioned above was carried out by press forming, and it was made the sheet shaped textiles consolidation object. Press-forming conditions were 50 mm and post forming [ 5-10 mm of ] before sheet thickness:shaping for the temperature of 80 \*\*, the pressure of 5 t, and application-of-pressure retention time 15 minutes. In the case of press forming, the moisture given to textiles evaporates and is removed.

[0022]

Although press forming was used by this example as a means of forming by compression, what is necessary is just a method which does not need to limit to this and can fabricate textiles on a high-density textiles consolidation object from the bulky state of low density. It is not necessary to limit to this and what is necessary is just to choose in consideration of a means to pelletize by cut processing by a post process, although the consolidation object was made into the sheet shaped gestalt in this example.

[0023]

(3) Cut processing of a textiles consolidation object (creation of a textiles consolidation pellet)

Cut processing of the textiles consolidation sheet created above was carried out with the cutter, and it was considered as a 5-10-mm one-side angle pellet. Pellet size can be suitably decided according to the use of the last process condition and mold goods. In this example, since cut processing of the sheet shaped textiles consolidation object was carried out, the cutter was used, but it is not necessary to limit to this and a suitable cut processing means can be used according to the shape of a required pellet, and size, corresponding to the gestalt of a textiles consolidation object.

[0024]

(4) Supply simultaneously the textiles consolidation pellet which created the textiles

consolidation pellet by a polylactic acid pellet and the mixed (creation of a pellet mixture) above, and a polylactic acid pellet (shape: a cylindrical shape, size:diameter =1-2mm, length =2-3mm) to the hopper of an extruder. Thereby, both pellets will be in a mixture state to a remarkable grade. In addition, it is good to stir both pellets mechanically within another container, and to carry out preliminary mixing, before supply in a hopper.

[0025]

(5) Shaping by extrusion

Extrusion molding of the pellet mixture was carried out, and the square-bar-like (20 mm[ in width ] x2-mm x100 mm in length) Plastic solid sample was obtained. [ in thickness ] The used extruder is a type which divides an extrusion sleeve into the four sections and carries out temperature control. Temperature control of the four sections (sections 1, 2, 3, and 4) from a pellet supply side to the exit of an extrusion-molding object was carried out as follows, respectively.

[0026]

<Extrusion sleeve temperature>

1:165 \*\* (pellet supply side) of sections

2:175 \*\* of sections

3:180-185 \*\* of sections

4:160-165 \*\* (product outlet side) of sections

The supplied pellet carries out temperature up of the inside of a sleeve gradually in the order of the section 1 -> section 2 -> section 3 in connection with going on, the melting point (170 \*\*) of polylactic acid is exceeded in the center region (sections 2-3) of sleeve length -- an elevated

temperature -- plastic flow is promoted, and in the product outlet side (section 4), from the melting point of polylactic acid, the temperature is lowered by even low temperature and it appears from a sleeve as a solid square-bar-like Plastic solid. When fabricating not by extrusion but by injection molding, it is desirable to preheat a mold at 50-100 °C generally.

[0027]

The same square-bar-like Plastic solid was created in the following procedure with the conventional method for comparison.

[0028]

#### (1) Kneading

A polylactic acid pellet and a cotton fiber are kneaded and it is considered as a massive mixture. Kneading conditions were 180 °C in temperature, and 50 rpm in number of rotations, and mixing time was 1 to 3 minutes.

[0029]

#### (2) Grinding (creation of a mixture pellet)

The massive mixture was ground and it was made the  $\phi$ 5-8mm pellet (mixed pellet).

[0030]

#### (3) Shaping

The mixed pellet was supplied to the hopper of the extruder and it fabricated by the same section temperature setting as an example. The square-bar-like Plastic solid of the same size as an example was acquired.

[0031]

three point bending intensity was measured about the example sample produced by the above, and the comparative example samples of 30 each. Measurement applied to JIS K7171 correspondingly. A result is shown in drawing 3. The comparative example samples produced with the conventional method were the intensity average value 57.13N and the deviation score 4.24N. On the other hand, the example samples produced by this invention method are the intensity average value 65.1N and the deviation score 1.6N.

Intensity improved and variation decreased.

[0032]

To having become light brown, the example sample is assuming the original white of the raw material, and design nature of a comparative example sample also improved.

[0033]

#### [Effect of the Invention]

According to this invention, a kneading process is not needed but the method of manufacturing the biodegradable fiber reinforced plastic which combined both without degrading a cellulosic fiber and polylactic acid is provided.

[Brief Description of the Drawings]

[Drawing 1] Drawing 1 is a flow chart which shows process drawing of (1) this invention method, and process drawing of (2) conventional methods.

[Drawing 2] Drawing 2 is a mimetic diagram showing procedure (1) - (5) in an example of the method by this invention.

[Drawing 3] Drawing 2 is a graph which shows a bending test result respectively about the example sample by (1) this invention, and the comparative example sample by (2) conventional methods.